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BOTANY.—*The anay, a new edible-fruited relative of the avocado.* S. F. BLAKE, Bureau of Plant Industry.

One of the most interesting results of the explorations in search of new and desirable avocados and related fruits, carried on in Central America for several years past by Wilson Popenoe of the Office of Seed and Plant Introduction, is the discovery of the anay. Guided by the reports of natives, Mr. Popenoe first met with the species on September 23, 1916, when two trees were found at the entrance to the Finca El Compromiso, half a mile from Mazatenango, Guatemala, at an elevation of about 365 meters. Other trees were known to the natives in the near-by forest, and were visited by them at the proper season to secure the fruit. The two trees seen by Mr. Popenoe had been left to provide shade for young coffee trees when the forest was cleared. They were about 22 meters high, with the tall and slender trunk bare of branches for a considerable distance, and an open rounded crown. On this occasion Mr. Popenoe, being unable to find a native venturesome enough to climb the trees, had to content himself with pieces of the bark and with some of the fruits, which were lying in profusion on the ground. He also secured leaves from sucker shoots at the base of one tree, but comparison with specimens secured from the same tree on a later trip shows that these belong to some other plant.

The fruits of the anay, which ripen in August and September, are very similar in external appearance to those of certain types

of avocado (*Persea americana*). They are 10 to 15 cm. long, ellipsoid-pyriform, sometimes curved, sometimes pointed at apex, often with sharply defined neck, with the body slightly compressed, and smooth, glossy, purplish black surface. The skin is very thin and membranous, adhering closely to the firm, oily, rather scanty flesh. This is divided into two zones of color, equal in thickness, the outer pale green, the inner greenish cream-color, both being more sharply defined than is ordinarily the case in the cultivated avocado. The flesh has a rich, bland flavor, like that of a very good avocado, but faintly sweetish. The large, obovoid seed, with the pointed end toward the base of the fruit, has a thick, almost fibrous, outer seed coat and a membranous inner one closely including the cotyledons, but not always reaching to their apex. The pubescent plumule lies immediately at the base of the cotyledons, while in the avocado it is located some distance above this point. The fruits fall while still hard, ripening in two or three days, and germinating freely on the ground beneath the parent tree. Most of the specimens found by Mr. Popenoe had been attacked by insects, which tunneled through the seeds.

The notes from which this description of the fruit has been drawn up were made by Mr. Popenoe on his first visit to the trees. On a later visit, on January 17, 1917, a mozo was found who ascended one of the trees by means of a near-by palm and threw down branchlets with leaves, young fruit, and a very few flowers. Study of these shows that the anay is not a *Persea*, as Mr. Popenoe at first supposed, but an undescribed species of the genus *Hufelandia*, which is at once distinguished from the avocado (*Persea americana*) and its near relatives by the fact that the anthers are 2-celled instead of 4-celled.

Since collecting the anay at Mazatenango, on the west coast of Guatemala, Mr. Popenoe has found it at Chamá, on the Río Chisoy in the Usumacinta basin in Alta Verapaz, northeastern Guatemala, at an altitude of about 300 meters, although no specimens were obtained. It is the belief of Mr. Popenoe that the name of the old Maya settlement Anaité, farther north in

the same valley near the ruins of Menché Tinamit and Yaxchilan, has reference to the former abundance of the anay in the same region.

The anay, both in the vicinity of Mazatenango and in the Usumacinta Valley, grows in moist regions at an elevation of only 300 to 365 meters. For this reason Mr. Popenoe believes that it will not succeed in California, but that it may do well in southern Florida. Young trees grown from seeds collected by Mr. Popenoe are now cultivated in the Plant Introduction Garden at Miami, under the Seed and Plant Introduction number 43432, and their future will be watched with much interest. In its native haunts the species was reported by natives to flower in May, but from the specimens collected by Mr. Popenoe it is clear that the flowering season is December and January. The fruit ripens in August and September.

As this species of *Hufelandia* is known throughout its range as anay (pronounced ă-nī,[1] and as it is intended to bear the same name on its introduction into culture in the United States, it may be called

Hufelandia anay Blake, sp. nov.

Large tree, up to about 22 meters high, with thick, reddish brown bark; branchlets stout, angulate, densely griseous or rufescent-puberulous with sordid incurved hairs, at length glabrate; leaves alternate, rather crowded toward the ends of the branches, the blades 13 to 20 cm. long, 7.5 to 10 cm. wide, oval, abruptly short-pointed (acumen about 1 cm. long, obtuse), rounded to cuneate at base, chartaceous, pinnate-veined with 10 to 14 pairs of lateral veins diverging at an angle of about 70°, above green, sordid-puberulous along costa and lateral veins, essentially glabrous on the slightly prominulous-reticulate surface, beneath glaucous, rather sparsely puberulous on the surface with whitish hairs, more densely so on veins with sordid loose hairs, with rather prominent secondary veins and obscure tertiaries; petioles stout, sulcate, sordid-puberulous especially above, 2.5 to 3.5 cm. long; panicles axillary, sordid-puberulous, sparsely branched (at least in fruit) and rather slender, 9 to 15 cm. long (including the 4 to 7 cm. long peduncle); pedicels in young fruit somewhat clavate, about 3 mm. long; perianth sordid-pilosulous on both sides, 2.5 mm. long, the segments subequal, oval, rounded at apex, 1.5 mm. wide; perianth tube extremely short; stamens of series I oblong-elliptic, 1.9

[1] The system of diacritical marks here used is that of Webster's Dictionary.

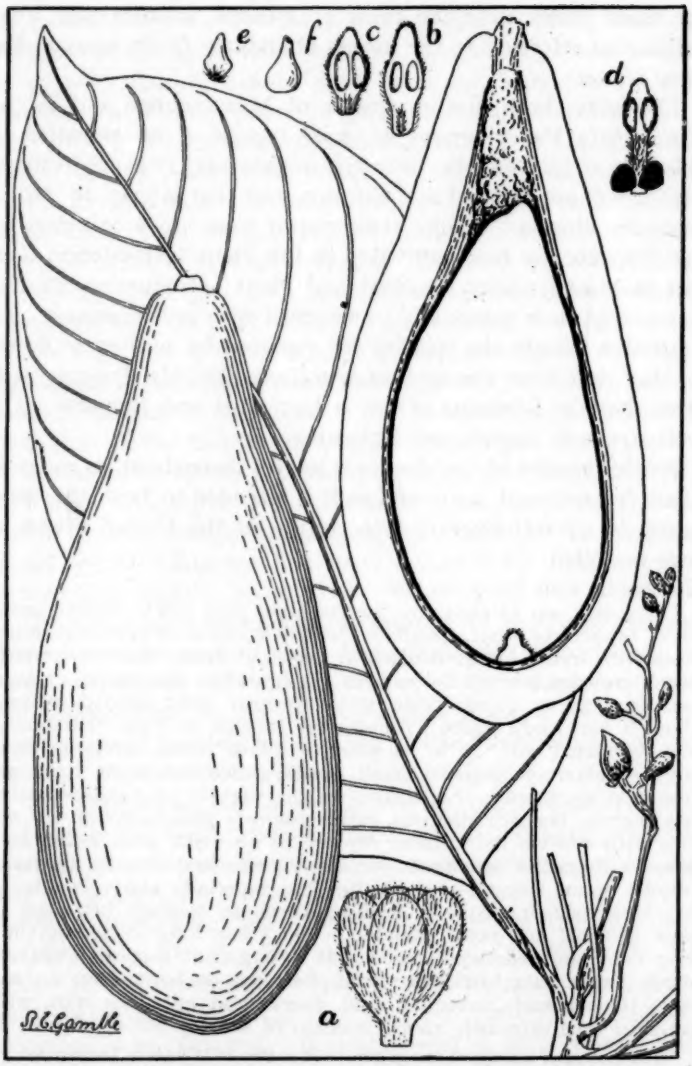

Fig. 1.—*Hufelandia anay*. Leaf, fruit, and longitudinal section through fruit and seed, showing plumule at base of seed, all nearly natural size; *a*, flower; *b*, stamen of series I; *c*, stamen of series II; *d*, stamen of series III, seen from dorsal side; *e*, staminode; *f*, ovary. Details about scale 10.

mm. long, sordid-pilose on back and ciliate to upper level of anther sacs, papillose above, the filaments about 0.4 mm. long, pilose down middle inside, gradually widened into the 2-celled anther, this narrowed into an obtuse appendage about as long as the filament; those of series II similar, 1.5 mm. long, the filaments 0.35 mm. long, pilose on both sides, the 2-celled anther 0.65 mm. long, the triangular obtuse papillose tip 0.5 mm. long; those of series III 2 mm. long, the filaments comparatively slender, 1 mm. long, pilose outside and down midline within, bearing at base two globose sessile basally pilose glands slightly more than half as long as the filament, the oval extrorsely 2-celled anther 1 mm. long (including the 0.3 mm. long obtuse papillose appendage), papillose-pilosulous on back; staminodes triangular, acuminate, 0.9 mm. long, very shortly stipitate, pilose dorsally, glabrous inside; ovary subglobose, narrowed into and about equaling the stout style and obliquely conical stigma; fruit ellipsoid-pyriform, glossy black, thin-skinned, 10 to 15 cm. long; seed very large, obovoid, with thick outer coat; embryo at extreme base of cotyledons.

Type in the U. S. National Herbarium, no. 1011734, collected in loamy soil of tropical forest at Finca Compromiso, Mazatenango, Guatemala, at an altitude of about 365 meters, January 17, 1917, by Wilson Popenoe (no. 754).

Hufelandia anay is easily distinguished from the two species of the genus previously described from Mexico and Central America, *H. mexicana* Mez and *H. costaricensis* Mez Pittier, by the fact that its leaves are glaucous beneath. From *H. pendula* (Swartz) Nees, of the West Indies, which agrees in the glaucescence of its leaves, *H. anay* differs in its larger oval leaves persistently pubescent beneath, its larger sordid-pilosulous flowers, and its much larger fruit.

A related species, collected on the Volcan de Poás in Costa Rica by Mr. Henri Pittier some years ago, may also be described in this connection. The native name of this tree is not known, nor is the nature of its fruit.

Hufelandia ovalis Blake, sp. nov.

Medium-sized tree; branchlets stoutish, subangulate, olive-brown, cinereous-puberulous with appressed hairs, glabrate; leaves alternate, the blades 5.5 to 8 cm. long, 3 to 4.7 cm. wide, oval, acutish or obtuse, at base cuneate to rounded-cuneate, pinnate-veined with 6 to 7 pairs of prominulous lateral veins, thick-pergamentaceous, above dull green or slightly lucid, prominulous-reticulate, rather sparsely pilosulous with loose whitish hairs, glabrescent at maturity, beneath glaucous, finely prominulous-reticulate, pilosulous with loose, curved, whitish hairs, along the veins more densely sordid-pilosulous; petioles stout, flattish, sordid-pilosulous, 7 to 11 mm. long; peduncles axillary, loosely sordid-pilosulous, 2.5 to 3.5 cm. long; panicles ovoid, dense, shorter

than the leaves, sordidly tomentose-pilosulous, 1.8 to 2.5 cm. long, 1.5 to 3 cm. wide; pedicels 1 to 1.5 mm. long; perianth 2.5 mm. long, soon deciduous, sordidly pilosulous-tomentulose both sides, the tube obscure, the segments subequal, oval, rounded at tip; stamens of series I 2.2 mm. long, the stout filaments 0.8 mm. long, pilose on back and down midline within, the 2-celled ovate eciliate sparsely papillose anthers 1 mm. long, the quadrate obtuse appendage 0.3 mm. long; those of series II similar, 2.4 mm. long (filament 1 mm., anther 1.1 mm., appendage 0.3 mm.); those of series III 2.2 mm. long, the filaments slender, pilose, 1 mm. long, bearing at base 2 cordate-globose short-stipitate glands essentially as long, the extrorsely 2-celled anther 0.8 mm. long, the thick truncate appendage 0.4 mm. long; staminodes 1.1 mm. long, deltoid, acute, pilose on back and on the short, broad stipe; ovary glabrous, globose-ovoid, 1.5 mm. long, narrowed into the 0.5 mm. long style and oblique stigma.

Type in the U. S. National Herbarium, no. 578438, collected on the Volcan de Poás, Costa Rica, altitude 2300 meters, March 31, 1907, by H. Pittier (no. 2040).

Hufelandia ovalis is related to *H. anay* and *H. pendula*. From the former it may be easily distinguished by its much smaller, finely prominulous-reticulate leaves, its longer filaments, and its larger floral glands. From the latter it differs in its thicker more finely reticulate leaves, its dense ovoid panicle, and its longer filaments.

GENETICS.—*On Mendelian inheritance in crosses between mass-mutating and non-mass-mutating strains of* Oenothera pratincola.[1] FRIEDA COBB and H. H. BARTLETT.

A former paper[2] has dealt with the striking difference in mutability between certain strains of *Oenothera pratincola* that are morphologically identical. The strains in question were derived from seeds of wild plants collected in 1912 at Lexington, Kentucky. Several of them, typified by the strain designated as Lexington C, show only a moderate degree of mutability.

[1] Papers from the Department of Botany of the University of Michigan, No. 160. This paper is published as presented at the Pittsburgh (1917) meeting of the Botanical Society of America. It has been lying in manuscript since the fall of 1917. The data upon which it is based have since been greatly amplified. The new results are based upon much larger cultures and verify those here presented, but are not yet ready for publication. A preliminary abstract has appeared elsewhere. (Proc. Mich. Acad. Sci. 1918: 151. 1919.)

[2] BARTLETT, H. H. *Mass mutation in* Oenothera pratincola. Bot. Gaz. 60: 425–456. 1915.

They have given rise to a number of interesting mutations, one of which, mut. *nummularia*, is especially conspicuous in the young seedling stage because of its orbicular leaves, and was on that account the first to receive intensive study.[3] In general, the mutations of the relatively stable strains belong to two types, (a) those that come true when self-pollinated and show matroclinic inheritance in crosses with the specific type (*e. g.*, mut. *nummularia*) and, (b) those that split in every generation into the mutational type and the specific type, regardless of whether they are self-pollinated or pollinated by the specific type. The latter are similar to *Oenothera stenomeres* mut. *lasiopetala*[4] and to certain mutations from *Oenothera Lamarckiana* described by de Vries.[5]

A strain of *Oenothera pratincola* differing from all the rest has been designated as Lexington E. It has given rise to some, but not all, of the mutations thrown by the other strains, and in addition it has produced in large numbers a series of characteristic mutations having certain characters in common that are not met with among the mutations of the other strains. These characters are revoluteness of the leaves and the possession of a peculiar subterminal filiform appendage on the lower surface of the leaf, into which the midvein is diverted. All of the characteristic mutations of the mass-mutant strain, Lexington E, come true, whether self-pollinated or pollinated by the f. *typica* of strain E. To be more precise, they come true in the sense that they do not revert, in part of each generation, to f. *typica*, although they may be very highly mutable, and give rise to other members of the revolute-leaved series of mutations.

In brief, there are relatively stable strains of *Oenothera pratincola*, such as Lexington C, which throw small numbers of flat-leaved mutations belonging to several kinds, one of the most

[3] BARTLETT, H. H. *Additional evidence of mutation in* Oenothera. Bot. Gaz. 59: 81–123. 1915.

[4] BARTLETT, H. H. *The mutations of* Oenothera stenomeres. Amer. Journ. Bot. 2: 100–109. 1915.

[5] DE VRIES, HUGO. *New dimorphic mutants of the Oenotheras.* Bot. Gaz. 62: 249–280. 1916.

characteristic being mut. *nummularia*. There is also one highly mutable (mass-mutant) strain, Lexington E, which gives rise in large numbers to several kinds of revolute-leaved mutations, produced by no other strain. The most notable of them is mut. *formosa*. Lexington E also throws some of the flat-leaved mutations which are more commonly met with in the other strains, but mut. *nummularia* has never appeared among them.

All experiments thus far made with the revolute-leaved mutations indicate that in crosses with f. *typica* of the same strain inheritance is matroclinic. Their behavior affords a parallel to that of *Oenothera Reynoldsii* and its mutations.[6] Because of their markedly dissimilar mutation phenomena, it was suspected that the rule of matroclinic inheritance might not hold in crosses between strains C and E. In order to test this point, and also to determine the effect of crossing on the mutability of the strains, the following pollinations were made in 1915:

f. *typica* C × f. *typica* E (unsuccessful).
f. *typical* E × f. *typica* C (unsuccessful).
f. *typica C* × mut. *formosa* E (successful).
mut. *formosa* E × f. *typica* C (unsuccessful).
mut. *latifolia* C × mut. *formosa* E (unsuccessful).
mut. *formosa* E × mut. *latifolia* C (successful).
mut. *gynocrates* C × mut. *formosa* E (successful).
mut. *formosa* E × mut. *gynocrates* C (successful).

Unfortunately, as indicated above, several of the more important crosses were unsuccessfully attempted. An effort to repeat them in 1916 failed because of unfavorable weather conditions. No significance is attached to the failures, since it is believed that all of the forms are fertile *inter se*. Probably the next repetition of the crosses, under favorable conditions, will result in a complete series. In any event the delay in rounding out the experiment must be considerable, and since important results have already been obtained we have determined to present the data at hand.

[6] La Rue, Carl D., and Bartlett, H. H. *Matroclinic inheritance in mutation crosses of* Oenothera Reynoldsii. Amer. Journ. Bot. 4: 119–144. 1917.

A NEW CASE OF MENDELIAN INHERITANCE IN OENOTHERA.

Perhaps the most authentic case of Mendelian inheritance in the group of the evening-primroses is that afforded by *Oenothera brevistylis*, which acts as a recessive in crosses with its parent species, *Oe. Lamarckiana*, with other mutations from *Oe. Lamarckiana*, and even with unrelated species.[7,8] Another instance is that of the dwarf mutation from *Oe. gigas*.[9] Both of these cases have been discovered by de Vries. Heribert-Nilsson[10] has presented an elaborate Mendelian explanation of Oenothera genetics which is chiefly remarkable for its failure to square with the facts. It is based upon a supposed monohybrid segregation in crosses between red- and white-nerved races of *Oe. Lamarckiana*. He failed to find dominant homozygotes, and the evidence of Mendelian behavior is anything but clear. Gates[11] has argued that *Oenothera rubricalyx* acts as a Mendelian dominant in crosses with *Oe. rubrinervis*, but the question is in controversy between Gates and Shull[12] and cannot for the present be regarded as settled. It is obvious that the whole subject of Mendelian inheritance in Oenothera needs further investigation.

Our data deal with the crosses of mut. *formosa* E, pollinated by two of the flat-leaved mutations of the C strain. The former is the most fertile and vigorous of the revolute-leaved mutations.

[7] DE VRIES, HUGO. *Die Mutations-Theorie*. 1: 223; 2: 151–179, 429.

[8] DAVIS, B. M. *The segregation of* Oenothera brevistylis *from crosses with* Oe. Lamarckiana. Genetics 3: 501–533. 1918.

[9] DE VRIES, HUGO. Oenothera gigas nanella, *a Mendelian mutant*. Bot. Gaz. 60: 337–345. 1915.

[10] HERIBERT-NILSSON, N. *Die Variabilität der* Oenothera Lamarckiana *und das Problem der Mutation*. Zeitschr. für ind. Abst. Vererb. 8: 89–231. 1912.

HERIBERT-NILSSON, N. *Die Spaltungserscheinungen der* Oenothera Lamarckiana. Lunds Universitets Arsskrift. N. F., Avd. 2, 12: no. 1. pp. 132. 1915.

[11] GATES, R. R. *The mutation factor in evolution*. London, 1915. (Gives full references to the original papers dealing with *Oenothera rubricalyx*.)

[12] SHULL, G. H. *A peculiar negative correlation in* Oenothera *hybrids*. Journ. Genet. 4: 83–102. 1914.

GATES, R. R. *On the origin and behavior of* Oenothera rubricalyx. Journ. Genet. 4: 353–360. 1915.

GATES, R. R. *On successive duplicate mutations*. Biol. Bull. 29: 204–220. 1915.

It has been described and figured elsewhere (see footnote 2). The flat-leaved mutations of strain C were mut. *latifolia* and mut. *gynocrates*. The former, not infrequently produced by both strains C and E, gives dimorphic progenies containing mut. *latifolia* and f. *typica*. It, also, has already been described and figured.[13] Mut. *gynocrates* comes true from seed. It is not one of the better known mutations, but was used in the experiments because it happened to be in flower when the crosses were made, and seemed, in spite of its dwarf habit, to be a form of considerable vigor.

Both mut. *latifolia* and mut. *gynocrates* have pollen that is equivalent to that of the particular f. *typica* from which they are derived. In view of the failure of the crosses in which the pollen of f. *typica* C was used, it is especially important for the reader to understand the basis for this conclusion, which is true not only for these particular mutations, but for all others except those that appear to be tetraploid or triploid. All the progenies thus far grown from self-pollinated mut. *latifolia* have been dimorphic, consisting of f. *typica* and mut. *latifolia*. The f. *typica* from the dimorphic progenies breeds true, whereas the mutation continues to split, in every generation. When mut. *latifolia* is crossed with pollen of f. *typica*, the F_1 generation is quite like that resulting from self-pollination. Moreover, when pollen of the mutation is used in crosses with f. *typica* or its other mutations, nothing is obtained in the F_1 or subsequent generations which would not have resulted from self-pollination. Double reciprocal crosses still further substantiate the identity of the pollen of mut. *latifolia* with that of f. *typica*.

The same facts apply to mut. *formosa*, except that its progenies do not contain f. *typica*. It shows the same matroclinic inheritance in crosses with other forms belonging to the E strain. Culture records bearing out the conclusions that have been made with regard to the equivalence of its pollen with that of f. *typica* E and mut. *latifolia* E are given in table 1. The records are in

[13] TUPPER, W. W., and BARTLETT, H. H. *The relation of mutational characters to cell size.* Genetics 3: 93–106. 1918.

part new, in part assembled from a former publication (see footnote 2). The points brought out are:

(a) The essential similarity of the progenies of mut. *formosa*, when used as a seed parent, regardless of whether the pollen is derived from f. *typica*, mut. *latifolia*, or mut. *formosa*.

(b) The failure of pollen from different sources to influence the composition of progenies from the same f. *typica* seed-parent.

(c) The stability in the F_2 generation of f. *typica* derived from the cross f. *typica* × mut. *formosa*. It will indeed be observed that mut. *formosa* occurs in the progeny, but in no greater numbers than one might expect as a result of mutation.

TABLE 1

CULTURE RECORDS ILLUSTRATING THE EQUIVALENCE OF THE POLLEN IN F. *typica*, MUT. *latifolia*, AND MUT. *formosa*, WHEN THESE ARE *All* DERIVED FROM THE STRAIN OF *Oenothera pratincola* DESIGNATED AS LEXINGTON E

Parent	Seeds	Total plants	Classified	f. *typica*	mut. *formosa*	mut. *albicans*	mut. *revoluta*	mut. *sciacea*	Other muts.
typica[b]	1477	1036	All	266	10	57	54	644	5
typica[b] × *formosa*[c]	246	133	All	7	0	1	0	121	4
formosa[c]	177	146	All	0	130	2	0	14	0
formosa[d]	1371	1082	All	0	883	1	4	194	0
formosa[e] (1916)	334	120	All	0	93	0	1	26	0
formosa[e] (1917)	236	195	96	0	46	0	0	40	0
formosa[f]	518	100	49	0	0	0	0	0	0
formosa[d] × *typica*[a]	365	309	All	0	218	0	0	91	0
formosa[c] × *typica*[b]	333	177	All	0	151	0	3	23	0
typica[g] from (*typica*[b] × *formosa*[c])	446	262	All	103	3	5	2	149	0
formosa[f] × *latifolia*[h]	46	36	All	0	34	0	1	1	0

[a] Lex. E–5–217 *typica*. [b] Lex. E–5–229 *typica*. [c] Lex. E–5–206 *formosa*. [d] Lex. E–5–199 *formosa*. [e] Lex. E–5–199–28 *formosa*. [f] Lex. E–5–199–58 *formosa*. [g] Lex. E–5–(229 *typica* × 206 *formosa*)–7 *typica*. [h] Lex. E–36–41 *latifolia*.

For the pedigrees of all of these plants, consult Bot. Gaz. **60**: 425–456. 1915.

In table 2 are presented the data in regard to the F_1 generation of the crosses between strains E and C, with mut. *formosa* as the pistillate parent. Further crosses are being made, but

TABLE 2

F_1 PROGENIES OF CROSSES BETWEEN STRAINS E AND C, OF WHICH MUT. *formosa* WAS THE PISTILLATE PARENT

Parentage	Seeds	Plants	f. *typica*		f. *grisea*	f. *dimorpha*	Other muts.	Died
			normal	defective				
formosa E × *latifolia* C	358	209	90	30	11	72	1	5
formosa E × *gynocrates* C	190	97	41	26	1	10	2	17

[a] Culture number of the individual of mut. *formosa* used in both crosses, Lexington E–5–199–28.

Culture number of mut. *latifolia*, Lexington C–22–13–87; of mut. *gynocrates*, Lex. C–52–2–13.

there is no doubt, from the evidence at hand, that the flatness of the leaves in the C strain, but not in the E strain, acts as a dominant in crosses with the revolute mutations, when the latter enter into the cross as the female parent. When mut. *formosa* is pollinated by any form belonging to strain C, a diversified progeny is obtained, but all of the individuals have flat leaves. It will be seen by reference to table 1 that self-pollinated mut. *formosa* itself gives a highly diversified progeny, consisting of mut. *formosa*, mut. *albicans*, mut. *revoluta*, and mut. *setacea*. The three latter are interpreted as secondary mutations from the former. If one were to picture a progeny containing all of these revolute-leaved mutations, with their leaves flattened out, but with their other characters unaffected, the progeny of the cross in question (mut. *formosa* E × any form of strain C) would be partially depicted. Since f. *typica* is represented in such a progeny, it is considered to be the equivalent of mut. *formosa*. The other equivalents, or analogues, are not well known as yet, since it has been impossible thus far to obtain seeds from them. One of them, however, f. *grisea*, is assumed to be the equivalent of mut. *albicans* or mut. *revoluta*, and another, f. *dimorpha*, the most abundant of all, the equivalent of mut. *setacea*, Mut. *setacea* is not only the most abundant of the revolute forms, as they occur as secondary mutations in the progeny of mut. *formosa*, but it

also has a very distinctive habit that would enable it to be equated with the corresponding flat-leaved form. Its lower stem leaves, and the leaves of branches that do not bear inflorescences, are very narrowly linear, and exceedingly small. The leaves and leaf-like bracts of the upper portion of the stem, and of the inflorescence-bearing branches, are two or three times as broad, and much longer, giving an effect to the plants as though the flowering branches were all bud-sports on a plant of an entirely different sort. The dimorphic foliage of mut. *setacea* is well represented in a former paper (see footnote 2). F. *dimorpha* has exactly the same characteristic, the leaves being flat instead of revolute, but showing the same well-marked dimorphism. Nevertheless, after having equated mut. *formosa* with f. *typica*, mut. *albicans*(?) with f. *grisea*, and mut. *setacea* with f. *dimorpha*, there are still difficulties in the way of classifying the flat-leaved hybrid progeny. Each form shows far more variation than is customarily encountered in an Oenothera progeny.

In mut. *formosa* there is considerable variation in the development of the leaf blade, in addition to the revoluteness. If a leaf were flattened out, if would not be as broad as a corresponding leaf of f. *typica*. Moreover it would show a markedly irregular development of tissue. The flattening that takes place as a result of hybridization with strain C leaves the weaker plants with irregularly developed blades, although the stronger plants are in every respect fine f. *typica*. The variation with regard to blade development within each distinguishable form renders the cultures difficult to classify. Some of the plants that must be referred to f. *typica*, and that prove to act like f. *typica* in heredity, are much smaller and weaker than is commonly the case. It is generally when the plants are young that the imperfect development of leaf blades is obvious. As a plant becomes older, the leaves of the new growth are successively more and more normal, until at length it will pass a cursory examination as typical in every way. The smaller and weaker plants often bear branches as strong and robust as those of the best-developed *typica*. In a number of cases these branches have been so strik-

ingly different from the rest of the plant as to look exactly like bud sports. On the whole, it is impossible to draw any sharp line between the various phases of f. *typica*, although in table 2 a wholly arbitrary division into "normal f. *typica*" and "defective f. *typica*" has been made. The variations appear to be somatic, and highly subject to environmental conditions. Our hypothesis is that the freely segregating factor for flatness, introduced by the β gamete of strain C, only suffices to insure normal blade development under the most favorable environmental conditions.

TABLE 3

ANALYSIS OF F_2 SEEDLING CULTURES GROWN FROM NORMAL *typica* PARENTS BELONGING TO THE F_1 PROGENY OF THE CROSS MUT. *formosa* E × MUT. *latifolia* C, (LEXINGTON E–5–199–28 × C–22–13–87). AS SHOWN IN TABLE 4, ALL BUT AN INSIGNIFICANT NUMBER OF THE FLAT-LEAVED PLANTS WERE f. *typica*, AND THE REVOLUTE-LEAVED ONES WERE MUT. *formosa*

Parent	Seeds planted	Total plants	Flat-leaved	Revolute-leaved	Ratio
F_1 No. 4	932	315	238	77	756 : 244
	336	203	154	49	759 : 241
	1353	620	460	160	742 : 258
	1050	57	46	11	807 : 193
	3671	1195	898	297	752 : 248
F_1 No. 162	940	217	155	62	714 : 286
	291	246	187	59	760 : 240
	6279	4392	3258[a]	1134	742 : 258
	600	48	33	15	688 : 312
	8110	4903	3633	1270	741 : 259
F_1 No. 190	640	60	50	10	833 : 167
	954	85	64	21	753 : 247
	1594	145	114	31	786 : 214
F_1 No. 204	807	92	69	23	750 : 250
	1400	57	45	12	789 : 211
	2207	149	114	35	765 : 235
Grand total	15582	6392	4759	1633	744 : 256

[a] Four plants of this culture were mut. *nummularia*.

TABLE 4

ANALYSIS OF F_2 CULTURES GROWN TO MATURITY FROM THE SAME PARENT PLANTS AS THE SEEDLING CULTURES OF TABLE 3

Parent	Seeds planted	Total plants	Grown to maturity	f. *typica*	mut. *nummularia*	Other flat-leaved types	mut. *formosa*	Ratio
F_1 No. 4	932	315	315	238	0	0	77	756 : 244
	336	203	200	154	0	0	46	770 : 230
	1268	518	515	392	0	0	123	761 : 239
F_1 No. 162	940	217	207	143	2	1	61	705 : 295
	291	246	239	178	1	5	55	770 : 230
	1231	463	446	321	3	6	116	740 : 260
F_1 No. 190	954	85	85	64	0	0	21	753 : 247
F_1 No. 204	807	92	90	62	1	4	23	745 : 255
Grand total	4260	1158	1136	839	4	10	283	751 : 249

TABLE 5

ANALYSIS OF F_2 CULTURES GROWN FROM DEFECTIVE *typica* PARENTS BELONGING TO THE F_1 PROGENY OF THE CROSS MUT. *formosa* E × MUT. *latifolia* C (LEXINGTON E–5–199–28 × C–22–13–87). IN SHARP CONTRAST WITH THE NORMAL PROGENIES FROM NORMAL PARENTS (RECORDED IN TABLES 3 AND 4) THE PROGENIESFROM DEFECTIVE *typica* PLANTS CONSIST LARGELY OF DEFECTIVE PLANTS. NORMAL BUD SPORTS ON DEFECTIVE PLANTS, HOWEVER, GIVE RISE TO NORMAL OFFSPRING ONLY

Parent	Seeds planted	Total plants	Retained and classified	f. *typica*		mut. *formosa*		Other types
				(normal)	(defective)	(normal)	(defective)	
F_1, No. 30 defective	648	56	51	8	34	6	3	0
F_1, No. 31a defective	741	175	167	96	27	39	3	2
F_1 No. 31b normal bud sport	617	40	40	29	0	11	0	0
F_1, No. 39a defective	648[a]	126	126	17	96	13[a]	0	0
	446	165	129	4	88	1	36	0
F_1, No. 39b, normal bud sport	1008	100	96	67	0	29	0	0

[a] This one culture was classified in the seedling stage, which fact probably accounts for the failure to distinguish the class designated as "defective mut. *formosa*." The other cultures were all analyzed at maturity.

Tables 3 and 4 present the data showing segregation into f. *typica* and mut. *formosa* in the F_2 generation grown from four self-pollinated *typica* individuals of the cross mut. *formosa* E× mut. *latifolia* C. In table 3, which is based upon the classification of seedlings, the only distinction is between flat-leaved individuals (mostly f. *typica*) and revolute-leaved (mostly mut. *formosa*). The difference between the two types of leaves is perfectly clear in very young seedlings, though the different revolute-leaved mutations are not easily distinguished from one another, nor some of the flat-leaved mutations from f. *typica*, when very young. The cultures were too large to be carried to maturity as a whole, but the seedling classification was verified by growing to maturity a sufficiently large number of the plants.

Table 4, based upon the plants which were under observation throughout the entire life cycle, shows that there was no significant error in the classification of table 3. The revolute-leaved plants were all correctly identified as mut. *formosa*, and among the flat-leaved plants there was only a negligible proportion of mutations. The ratio of flat to revolute conforms to the simple 3 : 1 Mendelian ratio. The deviations from expectation are very slight, and fall on both sides of the theoretical ratio. The total progeny of each one of the four parents is in quite or almost as good agreement with expectation as is the sum of all four progenies. The total of 6,392 plants, from four parents, gives the ratio 744 : 256, in unusually good accord with the expected ratio 750 : 250.

The reader will notice that the mean germination is only 41 per cent, and that although the germination of the several cultures varies from 4 per cent to 84 per cent, the ratio is nevertheless not seriously disturbed. The probability is therefore great that we are dealing with a case of simple Mendelian inheritance, uncomplicated by selective elimination of zygotes. Incidentally, the results should tend to reassure anyone who may have feared that the work with Oenothera is in general unreliable, on account of the low germinations frequently recorded.

It has already been noted that some of the plants resulting from the cross between strains E and C were characterized by defective leaf development, and that some defective *typica* individuals bore normal branches, which had every appearance of being bud sports. In two such cases separate progenies were grown from seeds of the normal and defective portions of the same plant, with the very striking results summarized in table 5. The progenies contain only normal plants if derived from seeds borne on the normal bud sport, but if derived from seeds of the defective part of the plant, they contain a considerable proportion of plants classified as defective f. *typica*. The cultures are large enough to afford conclusive evidence that whatever the change may be that results in the production of normal from defective f. *typica*, the change is one that may come about in the somatic cells, and, once having come about, is permanent.

As a final proof of the Mendelian nature of the segregation indicated by the 3 : 1 ratio in the F_2 generation, F_3 progenies have been grown from a large number of self-pollinated normal *typica* individuals, in order to demonstrate the existence of homozygous and heterozygous dominants in the ratio 1 : 2 in the F_2 generation. The results are not included in this paper for the reason that they are still being added to and it does not seem desirable to publish only a portion of the data. However, it may be stated that not only do the expected classes occur in the correct ratio in the F_2 generation, but also that the heterozygotes continue to split in the 3 : 1 ratio. The homozygotes of both classes breed true.

Having established the non-Mendelian behavior of the character-pair flatness *vs.* revoluteness within strain E, and having shown that flatness when introduced into strain E by crossing a revolute-leaved type of the latter with strain C, does act in a Mendelian manner, it remains to indicate a possible explanation of the phenomena.

THE HYPOTHESIS OF HETEROGAMETISM.

In accordance with the hypothesis of nonequivalent gametes, which has been decidedly helpful in the interpretation of some

of the genetical peculiarities of Oenothera[14] (see also footnote 6), the male gametes of all of the mutations concerned are thought of as β gametes, and as exactly like the β gametes of the particular f. *typica* from which each mutation was derived. It has been assumed that the appearance of mutations showing matroclinic inheritance in crosses with the parent form is due to changes involving the α gametes, which bear various factors not represented in the β gametes. Such mutations constitute the greater number of those derived from *Oenothera pratincola*. They appear as the result of some modification of the uncompensated factors of the generally female α gametes, and therefore breed true from the first. The generally male β gametes of *Oe. pratincola* have as yet given rise to no mutations that have been detected, but de Vries[15] has found that one of the mutations of *Oenothera biennis* (var. *sulfurea*) shows patroclinic inheritance in crosses with its parent, and is therefore presumably such a mutation. In the heterogametic species of Oenothera, mutations involving the uncompensated factors of the α gametes obviously cannot show Mendelian inheritance. If the α gametes are female, inheritance must be matroclinic.

Since such a conception as that of a series of different mutations, or even of different species, in which the differentiation is brought about wholly by the female gamete, is justifiably foreign to current thought, it may be well to restate some of the grounds for its adoption.

It is a fundamental tenet of Mendelism that in homozygous material the two homologues chromosomes of each pair are equivalent and interchangeable. In heterozygous material one or more chromosomes are modified, but still remain interchangeable with their mates. If the uncompensated characters of the α gamete were borne in one chromosome, the only essential difference that would obtain between the conceptions of heterozygosis and of heterogametism would concern the unequal distribution of α

[14] BARTLETT, H. H. *The status of the Mutation Theory, with especial reference to* Oenothera. Amer. Nat. 50: 513–529. 1916.

[15] DE VRIES, H. *Gruppenweise Artbildung*, p. 298.

and β gametes between the two sexes. In view of the very large number of modifications occurring in the α gamete, however, it seems a more probable hypothesis that the uncompensated characters are borne by a group of chromosomes, which do not segregate freely, but pass together to one daughter cell or the other at the reduction division. Certainly such a hypothesis is useful in the interpretation of Oenothera genetics. The phenomena of matroclinic inheritance are clearly orderly enough in their own way, but are just as clearly non-Mendelian. As Shull (see footnote 11) has said: "Fundamental difficulties are encountered whenever attempts are made to apply to the Oenotheras rules of genetic behavior which are readily demonstrated in other groups of organisms. Equal confusion has arisen by the application of genetic experiences with the Oenotheras to species in which typical Mendelian phenomena appear. A hereditary mechanism must exist in Oenothera fundamentally different from that which distributes the Mendelian unit-characters."

According to the hypothesis of nonequivalent gametes, the Oenotheras should show Mendelian inheritance in cases where the factors concerned are carried by both α and β gametes. In case the factors are carried by only one kind of gamete, non-Mendelian inheritance must be the rule. The α and β gametes may be conceived of as due to the distribution to the daughter cells at meiosis of a distinctly maternal or distinctly paternal set of chromosomes. In other words, instead of a free segregation of chromosomes taking place, one must assume that the haploid set of chromosomes is reconstituted, as far as the factors peculiar to α and β gametes are concerned, just as it entered into the zygote at fertilization. As for the Mendelian characters, we assume that they are represented by factors carried in a residue of freely segregating chromosomes.

The conception of heterogametism may be reduced to the following series of propositions:

(1) In heterogametic species the zygote normally results from the conjugation of unlike gametes (α and β).

(2) The characteristic portion of each kind of gamete consists of a group of chromosomes that remain in association at meiosis. It is possible that the characteristic portion may consist of one chromosome only.

(3) The α gametes, and probably the β gametes also, carry factors in the characteristic portion that are not duplicated in the homologous portion of the complimentary gamete.

(4) Aside from the chromosomes that determine α and β gametes, the chromosomes of Oenothera are freely segregating, and carry factors for Mendelian characters.

(5) The α gametes are usually female, but may be male; the β gametes, on the contrary, are usually male, but sometimes female.

(6) Mutations occurring in the characteristic portion of either α or β gametes do not make their appearance by Mendelian segregation, and do not subsequently show Mendelian inheritance.

Our studies have led us to conclude that the difference between the mass-mutating and nonmass-mutating strains of *Oenothera pratincola* lies in the freely segregating chromosomes. In Lexington E the factor which determines leaf flatness is associated with the characteristic portion of the α gamete. It is not paired with a similar factor in the β gamete. In Lexington C, on the contrary, there is a paired factor for flatness, associated with one of the freely segregating pairs of chromosomes, and therefore carried by both α and β gametes. In Lexington E, the mutative modification of the unpaired factor for flatness results in the appearance of revolute-leaved mutations, which do not come about as a result of Mendelian segregation. The latter fact is proved by their enormous abundance in certain mass-mutating lines, an abundance far in excess of any Mendelian expectation, and by their matroclinic inheritance in crosses with the parent form.

The several revolute-leaved mutations differ from f. *typica* not only in the leaves, but in characters involving other organs also, the degree of the difference depending upon the extent of the mutative modification undergone by the α gamete. Whereas the production of all of the revolute-leaved mutations involves

one modification in common, there are additional modifications in the cases of all except mut. *formosa* which are peculiar to each mutation.

If the α gamete of Lexington C were to undergo exactly the same modification that in Lexington E brings about the production of a particular revolute-leaved mutation, the effect, as far as revoluteness is concerned, would be nullified by the factor pair for flatness in one of the pairs of freely segregating chromosomes. This factor pair has not yet become spontaneously heterozygous, and consequently no other strain except Lexington E has thrown revolute-leaved mutations.

Let α represent the nondissociating, characteristic portion of the α gamete, bearing a factor for flatness, and susceptible of mutative modification to α', in which the factor for flatness is inoperative. Then using the usual Mendelian notation for the freely segregating factor pair for flatness (FF = homozygous flat; ff = homozygous revolute) the constitution, phaenotype, and behavior of the various forms and hybrids involved in our experiments would be as follows:

f. typica C, mut. latifolia C, mut. gynocrates C,	$\alpha\beta$FF,	flat, and, with respect to this character, immutable.
f. typica E,	$\alpha\beta$ff,	flat, mutable.
mut. formosa E,	$\alpha'\beta$ff,	revolute.
typica E × formosa E,	$\alpha\beta$ff,	flat, mutable.
formosa E × typica E,	$\alpha'\beta$ff,	revolute, breeding true with respect to this character.
typica C × formosa E, F_1,	$\alpha\beta$Ff,	flat, segregating with respect to mutability.
typica C × formosa E, F_2,	1 $\alpha\beta$FF, 2 $\alpha\beta$Ff, 1 $\alpha\beta$ff,	flat, immutable, breeding true. flat, continuing the segregation of the F_1. flat, mutable, otherwise breeding true.
formosa E × latifolia C, F_1	$\alpha'\beta$Ff,	flat, segregating with respect to revoluteness.
formosa E × latifolia C, F_2	1$\alpha'\beta$FF, 2$\alpha'\beta$Ff 1$\alpha'\beta$ff	flat, non-segregating. flat, continuing the segregation of the F_1. revolute, breeding true.

The actual behavior of the various cultures is very satisfactorily accounted for by means of this formulation. That the revolute-leaved mutations breed true for revoluteness is shown in table 1. In the same table will be found the evidence that the revolute-leaved mutations give matroclinic progenies when crossed with the f. *typica* of the corresponding strain. It is the prevalence of matroclinic inheritance in these mutation crosses that makes a purely Mendelian explanation of their behavior impossible, and that requires the conception of α and β gametes. The data in regard to matroclinic inheritance are in some respects inadequate, and will be amplified as rapidly as possible.

The failure of Lexington C, and the other strains that resemble it, to throw revolute-leaved mutations is attested by the accumulated data for hundreds of cultures, aggregating many thousands of plants. Since the evidence is negative, it would be idle to assemble here the data supporting the conclusion that Lexington E is the only strain in which such mutations occur. The data regarding the mutability of Lexington E are in part published (see footnote 2).

According to the scheme above, one would expect the cross *typica* C × mut. *formosa* to act in a manner quite different from its reciprocal, which we have been considering. Instead of a Mendelian segregation of flat-leaved and revolute-leaved plants in the F_2 generation, one would expect only segregation with regard to the capability of occasionally undergoing the mutative change from flat to revolute. Segregation of this ability would mean that revolute-leaved plants might appear in the the F_2 generation, but, if present, each one would be the result of a separate, individual change; they would not be due to the inheritance of a changed condition, as was the case in the revolute-leaved recessives in the 3 : 1 segregation described.

Such a character, the capability of mutation, is not easy to deal with, since it is impossible to be sure that a particular parent might not show mutability if more of its seeds were germinated. The degree of mutability does not appear to show great uniformity from generation to generation, as may be seen by refer-

TABLE 6.

ANALYSIS OF THE F_1 AND F_2 GENERATIONS OF THE CROSS f. *typica* C × MUT. *formosa* E (LEX. C–22–7–40 *typica* × E–5–199–58 *formosa*), AND OF THE F_1 GENERATION OF THE CROSS MUT. *gynocrates* C × MUT. *formosa* E (LEX. C–52–2–13 × E–5–199–28). THE F_1 GENERATIONS CONSIST OF FLAT-LEAVED TYPES ONLY, AND THE F_2 GENERATIONS SHOW THE EFFECT OF CROSSING ONLY IN THAT THERE IS A SEGREGATION WITH REGARD TO THE CAPABILITY OF GIVING RISE TO REVOLUTE-LEAVED MUTATIONS.

Parentage	Generation	Seeds	Total plants	Retained and classified	f. *typica*	mut. *gynocrates*	Other flat-leaved forms	mut. *formosa*	mut. *albicans*	mut. *revoluta*	mut. *setacea*	rev.-leaved muts. not identified	Total rev.-leaved muts.
typica × *formosa*	F_1	258	87	87	87								0
(*typica* × *formosa*)-6 *typica*	F_2	1018	165	50	50								
		3270	626	50	50								
		4288	791	100	100								0
(*typica* × *formosa*)-51 *typica*	F_2	955	40	40	39	0	0	0		0	1	0	1
		9338	4536	4536	4492	0	4	16	3	6	59	66	140
		10293	4576	4576	4531	0	4	16	3	6	60	66	141
(*typica* × *formosa*)-54 *typica*	F_2	1109	274	200	198		2	0	0	0	0	0	0
		5170	1653	1644	1629		15	2	0	1	3	2	9
		6279	1927	1844	1827		17	2	0	1	3	2	9
gynocrates × *formosa*	F_1	54	26	17	0	8	9						0

ence to an earlier paper (see footnote 2). Some progenies contain many mutations, and mutability would therefore be detected by growing relatively few individuals. Others, on the contrary, contain very few, and a very large progeny indeed would have to be grown in order to feel reasonably sure of the non-mutability of the parent. The authors plan to gather further data bearing on what we may term the "inheritance of mutability" in these crosses between the strains of *Oe. pratincola*. For the present we shall give only the data contained in Table 6. As far as the results go they are in conformity with expectation. The F_1 progenies of crosses between any form of strain C and mut. *formosa* E resemble the C parent, in that the leaves are all flat. In the F_2 we may or may not detect mutations, since they may occur only among one-quarter of the progeny, those having the factorial composition $\alpha\beta$ff. It is of course always possible for α gametes to undergo mutative modification to the condition determining revoluteness, but the mutative modification, if it occurs, is masked in plants carrying the factor F, either from one or both parents (*i. e.*, in 3 out of 4 F_2 plants). In case the plant has the constitution $\alpha\beta$FF or $\alpha\beta$Ff it can never show revoluteness; however the α gametes may become modified.

THE PRODUCTION OF MUT. NUMMULARIA.

One especially interesting fact is that strain E after having been crossed with strain C gives rise to mut. *nummularia*. Under ordinary circumstances it never does so. Similar phenomena are sometimes viewed as due to metacliny. Metacliny, a term first used by de Vries,[16] may be explained in the terms of the $\alpha\beta$ hypothesis as follows: Although most female gametes are α, and most male gametes are β, there are exceptions to both rules, so that occasionally identical zygotes result from reversed fertilizations, the majority of the zygotes being of the constitution $\alpha\beta$, and only a few $\beta\alpha$. Cases of this sort have been described by La Rue and Bartlett. Among the mutation crosses of *Oe. Reynoldsii*. The production of mut. *nummularia* by

[16] DE VRIES, H. *Gruppenweise Artbildung*, pp. 308–310.

strain E, however, is not explainable by any such hypothesis. We have shown that the reciprocal crosses between strains C and E have a different factorial composition, and do not behave at all alike. To view as due to metacliny the occurrence of mut. *nummularia* in the cross E × C (see table 3) is inconsistent with our explanation of the Mendelian behavior of the character-pair flatness *vs.* revoluteness in the same crosses.

A logical explanation would appear to follow if we assume that the round leaves of mut. *nummularia*, although brought about by a change in the α group of chromosomes (or chromosome) of the female gamete, can come to expression only in the presence of the Mendelian factor F which can be introduced by the male β gamete of strain C. In other words, the round leaves of *nummularia* are due to the modification of α, but can reach expression only in the presence of the mendelian factor F. Just as mut. *formosa* can attain expression only in the *absence* of the factor F, and consequently never occurs in pure strain C, of which the f. *typica* has the composition $\alpha\beta$FF, so mut. *nummularia* attains expression only in the *presence* of the same factor, and is consequently never thrown by strain E, in which the f. *typica* has the composition $\alpha\beta$ff. On crossing the two strains, the α portion of the E gamete shows its potentiality for producing mut. *nummularia* when factor F is present; conversely the α portion of the C gamete shows its potentiality for the production of revolute-leaved mutations when the factor F is removed.

SUMMARY.

I. In *Oenothera pratincola* normal fertilization is assumed to take place by the fusion of two kinds of gametes, which are designated as α and β, respectively. Certain chromosomes of the α gametes carry character determiners which have no counterparts in the β gametes. On account of this unbalanced condition, mutations affecting uncompensated determiners appear at once, and neither in origin nor subsequently in heredity do they display Mendelian behavior.

II. On the basis of the preceding assumption it can be understood why the phenomenon known as mass-mutation should occasionally occur. Mass-mutation is a term descriptive of the origin of mutations in such inordinately large numbers that the cultures show no resemblance to Mendelian segregation.

III. In *Oenothera pratincola* the only mutations which have occurred through mass mutation are a series in which the leaves are revolute instead of flat. These revolute-leaved mutations have appeared in only one strain of the species, to the eye indistinguishable from other strains.

IV. It has been discovered that the difference between the mass-mutant and nonmass-mutant strains is that the latter carry a Mendelian factor determining flatness, in addition to the unbalanced determiner for flatness in the α portion of the α gamete. In the mass-mutating strain there is no Mendelian factor for flatness. The constitutions of the zygotes are therefore $\alpha\beta$ff and $\alpha\beta$FF, respectively, the former mutable with regard to flatness, giving rise to revolute-leaved forms with the constitution $\alpha'\beta$ff.

V. In *Oenothera pratincola* the α gametes are female. Reciprocal crosses are therefore unlike with regard to unbalanced characters (those confined to the α portion of the α gamete), being matroclinic in each case. Reciprocal crosses are alike as far as Mendelian characters are concerned. Therefore:

$\alpha'\beta$ff $\times$ $\alpha\beta$Ff $\longrightarrow$ $\alpha'\beta$Ff, flat-leaved, and heterozygous with regard to the Mendelian factor for flatness, segregating in the F_2 generation in the ratio 1 homozygous flat : 2 heterozygous flat : 1 homozygous revolute.

$\alpha\beta$FF $\times$ $\alpha'\beta$ff $\longrightarrow$ $\alpha\beta$Ff, flat-leaved, and heterozygous with regard to capability for giving rise to mutable stocks, segregating in the F_2 generation in the ratio 1 homozygous dominant, flat, immutable : 2 heterozygous, flat, like the F_1 generation : 1 homozygous recessive, flat only through the α determiner for flatness, and therefore mutable with regard to revoluteness.

VI. The results not only afford one of the best examples of Mendelism in *Oenothera* hitherto adduced, but likewise give an

indication as to when Mendelian behavior, as opposed to matrocliny or patrocliny, is to be expected.

VII. The production of mut. *nummularia*, which is never thrown by the strain which gives rise to revolute-leaved mutations, is shown to be due to mutation in the α portion of the α gamete, but nevertheless dependent for its expression upon the presence of the Mendelian factor F for flatness. It may be recalled that mut. *nummularia* shows matroclinic inheritance in crosses with the parent form, the fact which proves the first part of this proposition.

ANTHROPOLOGY.—*Some general notes on the Fox Indians. Part I. Historical.* TRUMAN MICHELSON, Bureau of American Ethnology.[1]

I have assembled here a number of miscellaneous notes on the Fox Indians. The inclusion of bibliographies is justified on the score that recent writers seem to have been totally ignorant of published sources of information on these Indians.

THE NATIVE NAME FOR "FOXES," AND SYNONYMY

The native name for "Foxes" is Me'ckwa'kī'ag$^{ki'}$[2] which means "Red-Earths." A good synonymy will be found at the end of the article *Fox* in the *Handbook of American Indians*.[3] To this the following may be added: Meskwa'kīhag^{i},[4] Meckwa'kīhag^{i}.[5] Meckwa'kihag^{i},[6] Meskwa''kī'à'g^{i},[7] Meckwa'kī'ag^{i},[8] Me'ckwa'kī-ag$^{ki'}$.[9] Musquaquas,[10] Musquakas,[11] Mesquakie,[12] Meskwakis,[13]

[1] Printed with permission of the Secretary of the Smithsonian Institution.
[2] MICHELSON. *Information*, 1917.
[3] Bur. Amer. Ethnol. Bull. 30.
[4] WILLIAM JONES. *Fox Texts*, passim.
[5] JONES. Ibidem, passim.
[6] JONES. Ibidem: 10.7; misprint?
[7] JONES. *Handbook of American Indian Languages*, Pt. 1: 741.
[8] MICHELSON. *Current Anthropological Literature*, 2: 234.
[9] MICHELSON. *Information*, 1917.
[10] *Annals of Iowa*, 1870: 366.
[11] Ibidem, 363.
[12] *Mesquakie Booster*.
[13] *Iowa Journal of History and Politics*, 4: 191.

me sga ki A ki,[14] mah squake ha ke,[15] Mus-quak-kie,[16] Mus-quak-kie-uck,[17] Mesh-kwa-ki-ha-gi,[18] Musquaukee,[19] Muskwakiuk,[20] Mskwakithak,[21] Red Earth(s),[22] Red-Earths,[23] People of the Red Earth,[24] Red-earth family,[25] de la Terre-Rouge,[26] Wa-go-sha-hugi,[27] Fuchsindianer,[28] UtAgāmi`g,[29] Watagamie,[30] Outhagamis,[31] Ottigaumis.[32]

The Menominee synonym is the equivalent of the Ojibwa one (vide supra), but the exact phonetics are uncertain; the Winnebago synonym means "foxes," but the exact phonetics are uncertain.[33]

In the vicinity of Tama, Iowa (their present location), they are not known as "Foxes," but as "Meskwakies," "Mesquakies," "Tama Indians."[34]

[14] Native name spelt in the current syllabary.

[15] *A collection of Meskwaki Manuscripts*, 1.

[16] J. MORSE's *Report to the Secretary of War*, 122.

[17] Ibidem.

[18] J. F. STEWARD. *Lost Maramech and earliest Chicago*, 1903.

[19] Ibidem.

[20] F. KARSCH-HAAK, *Das gleichgeschlechtliche Leben der Naturvölker*, 1: 328.

[21] Shawnee synonym collected by GATSCHET, of the Bureau of American Ethnology, years ago.

[22] STEWARD. Loc cit. passim; translation of la Potheril apud Blair, *Indian Tribes of the Upper Mississippi and Great Lakes Region*. Vol. 1: passim.

[23] JONES. *Fox Texts*, passim.

[24] STEWARD. Loc. cit.

[25] BLAIR. Loc. cit.

[26] LA POTHERIE. *Histoire de l'Amerique septentrionale*. 1722.

[27] STEWARD. Loc. cit.

[28] F. KARSCH-HAAK. Loc. cit.

[29] JONES. *Handbook of American Indian Languages*. Pt. 1: 741. This is the Ojibway synonym, meaning "People of the Other Shore" (JONES, Loc. cit. and *American Anthropologist*, N. S. 6: 370), or "Those who live on the opposite side" (WARREN, *History of the Ojibways:* 33). PARKMAN's statement (*Half-Century of Conflict*, 1: 333, footnote 1) that "The name Outagamie is Algonkin for a fox. Hence the French called the tribe Renards, and the Americans, Foxes," is echoed by KELLOG, *Wisc. Hist. Soc. Proc.* 1907: 142. This simply betrays ignorance of Algonkin languages. See also my discussion of the early history of the Foxes. The absurd blunder has been repeated by STEWARD, Op. cit. 79.

[30] STEWARD. Loc. cit.

[31] BELTRAMI. *A Pilgrimage*, 2: 169.

[32] Map in J. LONG's *Voyages and Travels*.

[33] MICHELSON. *Information*.

[34] MICHELSON. *Information*.

THE EARLY HISTORY OF FOX INDIANS

The general history of the Fox Indians is extremely well-known.[35] I shall accordingly only try to clear up the beginning of their history. First of all, the *Outitchakouk* are not the Foxes, as is stated in the index to the *Jesuit Relations* (ed. Thwaites).[36] Now we are told: "The Outagamis are of two lineages; those of one family call themselves Renards, and the others are of the Red-earth family."[37] Evidently something of this sort is to be understood by the statement in the *Jesuit Relations*,[38] "The mission of St. marc to the Outagami, where are the ouagoussak, Makoua, makoucoué, Mikissioua." For *ouagoussousak* simply means "foxes."[39] Whether or not a misunderstanding arose by taking the name of a gens as the name of the tribe,[40] the fact remains that some Indian tribes did and do call the Meskwakis by the equivalents of "foxes." Now the *Skenchiohronon* of the *Jesuit Relations* are not the Neuters as is commonly assumed,[41]

[35] A list of the more important papers dealing with this topic is as follows: Articles *Fox* and *Sauk* in *Handbook of American Indians* (Bur. Amer. Ethnol. Bull. 30), H. W. BECKWITH, *The Illinois and Indiana Indians*, 146–162; WARD, *Meskwakia*, Iowa Journ. Hist. Polit. 4: 179–189; WARD, *The Meskwaki people of to-day*, ibidem., 190–219; FERRIS, *The Sauk and Foxes of Franklin and Osage Counties*, Kans. State Hist. Coll. 11: 333–395; PARKMAN, *A half century of conflict*, chapters xii and xiv; J. F. STEWARD, *Lost Maramech and earliest Chicago* (1903); M. M. QUAIFE, *Chicago and the Old Northwest* (1913); S. S. HEBBERD, *Wisconsin under the Dominion of France* (1890); J. N. DAVIDSON, *Unnamed Wisconsin* (1895); F. J. TURNER, *Indian Trade in Wisconsin* (in *Johns Hopkins University Studies in Hist. Pol. Sci.* 1891); KELLOG, *The Fox Indians during the French Régime* (Wisc. State Hist. Soc. Proc. 1907: 142–188); RE(O)BOK, *The Last of the Mus-qua-kies* (reprinted in Iowa Hist. Record 17: 305–335). Quite a few facts can be gleaned from *A collection of Meskwaki Manuscripts*, prepared by Cha kä ta ko si, published by the State Historical Society of Iowa, 1907, but as no English translation accompanies the text, use of it is confined to a few specialists or Meskwaki Indians.

[36] See the *Handbook of American Indians* under the article *Atchakangouen*.

[37] LA POTHERIE. *Savage Allies of New France*, apud BLAIR, Op. cit. 1: 360.

[38] Ed. THWAITES, 58: 41.

[39] On the note, ibidem, 293, see various articles in the *Handbook of American Indians*.

[40] JONES, *Amer. Anthrop.* n. ser. 6: 370; *Handbook of American Indian Languages*. Pt. 1: 741; apud STEWARD, Loc. cit. 79.

[41] See the ed. of THWAITES, 8: 302.

but the Huron designation of the *Meskwakies*, as stated by Hewitt in the *Handbook of American Indians*. For *Skenchiohronon* means "the Fox people," and the identification by Hewitt rests also upon that made by Potier (circa 1750).[42] It should be expressly noted that the Wyandot designation for the Meskwakies, collected by Gatschet in 1881, namely, *Skäxshurunu* "fox people," derived from *skäxshu* "the red fox," is more than ample confirmatory evidence. Accordingly we know that Le Jeune mentions the Fox Indians in the *Relation* of 1640.[43] Now since the Fox are cited in connection with the Sauk, Potawatomi, Kickapoo, Winnebago, and Crane Miami we have every reason to believe that their habitat at the time was in the vicinity of the Green Bay region. For the identification of the Huattoehronon, Attistaehronon, Ontarahronon, Aoueatsiouaenhronon, and Attochingochronon see the *Handbook of American Indians*. [Hewitt's identifications are at least partially supported by Potier.] Le Jeune adds "I have taken their names from a Huron map that Father Paul Ragueneau sent me." It is not known from whom Ragueneau obtained the map, though it is natural to think of Nicolet in this connection, for Ragueneau had a conference with Nicolet in the spring of 1641 near Three Rivers.[44] As is known, Jean Nicolet was in the vicinity of Green Bay in 1634. Le Jeune (op. cit. 231) locates the Potawatomi and Nation of the Fork[45] as being in the neighborhood of the Winnebago, and adds (p. 233) "I will say, by the way, that sieur Nicolet, interpreter of the Algonquin and Huron languages for the Gentlemen of new France, has given me the names of these nations, which he himself has visited, for the most part in their own country." Now if the Potawatomi and the Nation of the Fork were in the neighborhood of the Winnebago in 1634, it is highly probable that Sauk and Fox also were at least in that general vicinity. There is no *argumentum ex silentio*, for Le

[42] PILLING. *Bibliography of Iroquoian languages*. Bur. Amer. Ethnol. Bull. 6: 135, 136.

[43] THWAITES' ed. of the *Jesuit Relations*, 18: 235.

[44] *Jesuit Relations*, ed. THWAITES, 8: note 29, 9: 312.

[45] Rasaouakoueton: see article *Nassauaketon* in the said *Handbook*.

Jeune expressly says, "These are the names of a part of the nations which are beyond the shores of the great river Saint Lawrence and of the great lakes of the Hurons on the North." I think that the following extracts from the *Jesuit Relations*[46] may clarify the situation: "the Ousaki, and other Tribes,— who, driven from their own abode, the Lands towards the South, near Missilimakinac, have sought refuge at the head of the bay;" "the Poteouatami, the Ousaki, and the nation of the Fork also live here, but as foreigners, driven by their fear of the Iroquois from their own territories, which lie between the Lake of the Hurons and that of the Ilinois." [Both extracts are from the *Relation* of 1670–'71.] It is not at all likely that the Sauk (Ousaki) would have remained in the lower Michigan peninsula to face the enemy alone after the Potawatomi and the Nation of the Fork had been driven out. We must rather assume a general exodus at the same time, including the Fox (the intimate relations of the Sauk and Fox are well known). Hence C. W. Butterfield[47] is surely in error regarding the Sauks, and probably the Foxes when he states that they had not migrated from the east at the time of Nicolet's great voyage. According to a note in the *Jesuit Relations*[48] the Skenchiohronon [Foxes, not Neuters] are indicated on (S.) Sanson's map (of 1656) by Squenguioron. As a matter of fact the map has Squenquioron, at the end of Lake Erie. If this identification be correct,[49] the map is probably inaccurate; we have seen above, that in 1640 Le Jeune cites the Fox in connection with the Suak, Potawatomi, Kickapoo, Winnebago, and Crane Miami which certainly points the region of Green Bay as their habitat. Now the differences between the language of the Sauks and Foxes, and Kickapoos for that matter, are very small; and if the ancient home of the Sauks was in the lower Michigan peninsula (vide supra), so was

[46] Ed. THWAITES, **55**: 103 and 183, respectively.

[47] JOHN NICOLET. *Discovery of the Northwest*, **64**: 1881.

[48] Ed. THWAITES, **8**: 302.

[49] See the synonymy under the article *Wyoming* in the *Handbook of American Indians* for BEAUCHAMP'S conjecture regarding Scahentoarrhon.

that of the Foxes. If the Foxes had been driven out previously, it is entirely possible small parties may have returned. But I do not think the traditional statements of the Sauk, Fox, and Ottawa,[50] locating the Foxes in the lower Michigan peninsula, should be taken too seriously, for it may well refer to the later raids, especially to the fight at Detroit. It would mean that traditional history, going back practically 200 years, could be relied upon. Similarly, traditional statements of the Foxes having been driven up the Grand River from the Gulf of St. Lawrence or having had their origin near Niagara Falls,[51] are to be rejected, because we know the history of the area under discussion for a time anterior to 1634. The construction that I place on the statements is that the wars with the Iroquois and Neuters made a deep impression, and that the geography is mixed; that the Foxes often went to Montreal, and even fought at Lake George; it is likely some children may have been born on such trips, and they may have been told their birth-place, and passed it on. Thus also is to be understood the well-known statement of Black Hawk. The Rhode Island origin of the Foxes[52] is too absurd to combat seriously. I may refer briefly to Tailhan's discussion of the early home of the Foxes.[53] His argumentum ex silentio falls to the ground, for the *Relation* of 1657–'58 says distinctly "you will see the names of the principal Nations,"[54] not "all the Nations." Kellog's paper suffers from a wrong identification of the *Outitchakouk* (vide supra), ignorance of the fact that the *Skenchiohronon* was a synonym of the Fox Indians, and from too great reliance on traditional history. The reference of Re(o)bok to Shea's article,[55] crediting the latter with stating that Nicolet met the Foxes in Wisconsin in 1634

[50] MARSTON, apud Blair, 21: 146; A. BLACK BIRD, *Hist. of the Ottawa and Chippewa Indians*, 24.

[51] FORSYTH, apud Blair, 2: 183–184; GRIGNON, *Wisc. Hist. Coll.* 3: 265.

[52] ATWATER. *Indians of the Northwest*, 88; repeated by GREEN, *The Mesquaki Indians*, Red Man 5: 47–52, 104–109; queried by RE(O)BOK, loc. cit.

[53] BLAIR. Vol. 2: 250, 251.

[54] *Jesuit Relations*, ed. THWAITES, 44: 239.

[55] Wisc. Hist. Soc. Coll. 3: 124–138.

is due to uncritical reading. Nicolet very likely met the Foxes in Wisconsin, but Shea does not say so. He begins his history of them in 1666–1667. Steward's discussion of the early history of the Foxes suffers from a wrong identification of the Ouachegami[56] with the (Outagami which shows his ignorance of Algonquian languages), his failure to know that *Skenchiohronon* is a synonym of Fox, and his too great reliance on traditional history; but it may be noted that he utilized the information contained in La Potherie regarding the two lineages of the Outagami which have been ignored by later writers.

The recent history of the Fox Indians can be readily followed in the *Reports* of the Commissioner of Indian Affairs, and local newspapers. The *Mesquakie Booster*, a periodical devoted to the present day interests of the Fox Indians, has recently discontinued.

POPULATION

In any attempt to determine the population of an Indian tribe in previous times, we must take into account exaggerations, either unintentional or intentional. The population of the Foxes is concisely treated in the articles Fox and Sauk in the *Handbook of American Indians*. The most reliable estimates of the entire Fox population in early times are those of Pike (1805) 1750, Lewis and Clark (1806) 1200, Beltrami (May 29, 1823) 1600, *Ann. d.l. Prop. de Foi* (1830) 1500, *Report of the Commissioner of Indian Affairs* (1837) 1600. Pike gives the number of warriors as 400, Lewis and Clark as 300. It will be seen that, roughly speaking, from their figures the total population is four times the number of warriors. In this way an estimate may be made for earlier times when only the warriors are listed. I now give some estimates of the number of warriors:

1666–1667 (*Jesuit Relations*) 1000 (gross exaggeration).
1667–1670 (*Jesuit Relations*), 400.
1714 (Charlevoix), 500.
1761 (Wisc. Hist. Soc. Coll. **1**: 32), 350.
1763 (Col. Dioc. N. Y. **10**: 583), 320.
1777 (Houck, Spanish régime, **1**: 146), 300–350.
1783 (Mass. Hist. Coll. I. 10 [1809]: 123), 300.

[56] Article *Wachegami* in *Handbook of American Indians*. Bur. Amer. Ethnol. Bull. 30.

With the exception of the first estimate, we have a series that is entirely reasonable. The struggle at the Butte des Morts easily accounts for the decrease in population after 1714. The estimates of Bouquet and Chauvignerie in 1764 and 1763, respectively,[57] and Buchanan[58] are too modest, as is that of Jno. Long (about 1780, published 1791). With the exception of Chauvignerie (100), these range from 200–250. The statement of Charlevoix that there were 3000 women in 1714 is pure exaggeration. This would make the number of women six times that of the men, which does not accord with the proportions given by Pike and Lewis and Clark. The extravagant figure of 3202 in 1819[59] as the total population must be considered as a deliberate invention. The figure of 2000 in 1822 (given by Marston and Morse) is a simple exaggeration. The last separate enumeration of the Foxes is in 1841, where 1600 is given. Here our real difficulties begin. For by enumeration with the Sauks, we lose trace (for a while at least) of the number of true Foxes. And what is more, we are involved in the gross exaggerations in the enumerations of the Sauks. To make the matter clear, and at the same time not to go into this at too great length as it is a side-issue, it is necessary to state that the most reliable estimate of the Sauks in the early days is that of Lewis and Clark, namely, 2000. That of Pike is 2850, that of the *Ann. d. l. Prop. de Foi* (1830) is 2400. These are exaggerations of a comparatively mild order; soon we see the wildest kind of guesses; in 1819 we get 3847, in 1822, 3000 and 4500, in 1823, 4800, which figure we find again in 1837 and 1841, not counting the Missouri Sauks (500, the percentage of Foxes among these cannot be determined, but apparently was small). Drake in 1820 gives the combined Sauk and Fox as about 3000 "one-fifth of whom may be warriors." The state of affairs can be seen by the remarks of Marsh in 1834; we are told that the agent counted the combined Sauk and Fox as 6400, but that others estimated the number

[57] Schoolcraft, 5: 554, 559.

[58] Between 1770–1780, reported by HECKWELDER.

[59] Wisc. Hist. Soc. Coll. 20.

to be between 2000 and 2400, adding that he himself considered 2000 to be nearer the figure. Apparently the fact that the population was exaggerated was gradually making headway in officialdom, for, in the *Report of the Commissioner of Indian Affairs* in 1838, this is taken into account and the Mississippi Sauk population is given as 2100. But such is the attachment for large figures, apparently to balance at least partially his over-estimates of the Sauks, that the agent gives the reckless figure of 2446 for the Foxes. Unfortunately officialdom could not be contented with such modest figures for the Sauks, and in 1841 we have the old exaggeration (vide supra). A wholesome reaction came in the next year when a treaty for the removal of the Sauks and Foxes from Iowa was effected, and from 1842 to 1845 the combined Sauk and Fox population is given as about 2300. An attempt at honesty was made in 1841 when in spite of the erroneous separate enumeration of the Sauks, the combined population of the Sauk and Fox of the Mississippi is given as 2300. It is to be borne in mind that in the same official document the Fox population is given as 1600! Other exaggerations of the Sauk population are passed over, save that in 1826 Forsyth gives the number of warriors as 1000 and Keocuck as 1200.[60] Summing up for the population prior to the removal to Kansas, we may say that if we accept the figures of Lewis and Clark, Drake, Marsh, and the report of the Commissioner of Indian Affairs for 1842, we have an orderly sequence, such as may be readily accounted for (as by the Black Hawk war, and natural causes); the acceptance of the larger figures (and this applies especially to the Sauk) involves us in hopeless meshes. From now, owing to the merging of the enumeration, the situation is difficult. The removal of Indian tribes ordi-

[60] WENNEBEA (apud *Narrative of an Expedition to the Source of St. Peter's River . . . 1823*, compiled by WILLIAM H. KEATING, vol. 1: p. 219) says, "upwards of a thousand warriors . . . the real number of warriors of pure Sauk extraction does not . . . exceed two hundred." The adoption of prisoners of war accounts for the rest. Are we to understand something of this sort from Forsyth's and Keocuck's figures?

narily involves a considerable loss in population; but in 1849 the combined Sauk and Fox of the Mississippi is given as 3000; but it is officially known that one-half the Sauk and Fox of the Missouri had joined them. In 1851 three hundred perished by cholera; in 1852 three hundred died of smallpox. According to the report of the Commissioner of Indian Affairs for 1853 there were 2173 Sauk and Fox of the Mississippi; in the report for 1857 we learn the Sauk and Fox of the Mississippi in 1853 was 1748: but no explanation of the discrepancy is given. In 1857 the population of the Sauk and Fox of the Mississippi is given as 1367, and those of the Missouri as 350. The probable interpretation of this is that the Sauk and Fox of the Missouri who had joined those of the Mississippi had rejoined their own body. From this time on the population diminished slowly but surely; and the details can be readily found in the reports of the Commissioner of Indian Affairs. What is more important to us is that the Foxes (at least a majority of them) eventually left Kansas for Iowa, where they purchased land. Their population eventually reached to about 400 when an epidemic of smallpox swept many away. To-day they are 350 in round numbers. Officially they are called "Sauk and Fox;" but in language they are Foxes; and also in ethnology. Even the government in its treaties recognized the Foxes as distinct as late as 1859 so that the much heralded amalgamation with the Sauks is shown to be a myth. It may be noted that there are some Sauks among "Sauk and Fox" near Tama, Iowa; and many others have Sauk blood; still others have French, English Potawatomi, or Winnebago blood; and some are hopeless mixtures. Briefly, I doubt if there are still (1918) any Foxes living who are absolutely free from foreign mixture. Another point may here be taken up. Officially the number of full-blooded Indians is very high; but this is an exaggeration, as I know from personal field work. In closing it may be said that there are some Foxes among the "Sauk and Fox" (who are mainly Sauks) of Oklahoma, and

others doubtless have Fox blood; but their proportion is unknown.[61]

THE ALLEGED IROQUOIS ORIGIN OF THE FOXES

N. H. Winchell,[62] attempts to prove that the Foxes (Outagami) were originally an Iroquoian people (thus repeating Smith's old error). The arguments adduced are so absurd that they would not merit any attention were the paper not in a periodical of high standing. The statement that the Foxes were almost annihilated by the Ojibwa in 1777 simply shows that Winchell could not have investigated the question of the Fox population with any care; the figures given by Lewis and Clark, Pike, *Ann. d. Prop. de la Foi*, Marston, and Forsyth, give the lie direct to this imputation.[63] The argument is that the Foxes being virtually annihilated by the Ojibwa were absorbed by the Sauks, and began to be transformed, language and all, and consequently present linguistic investigations would be of little value unless such an amalgamation were taken into consideration. The question of annihilation has been dealt with above; as to absorption, undoubtedly many Foxes have Sauk blood, but Fox ethnology has remained distinct from Sauk ethnology in at least certain respects.[64] The linguistic point raised by Winchell can readily be overthrown. The language spoken by the Foxes of to-day is more archaic than that spoken by living Sauks, as I have shown elsewhere;[65] and it should be noted that Kickapoo agrees with Fox in many of these differences. Hence the ques-

[61] STEWARD (*Lost Maramech and earliest Chicago*, 1903), discusses the Sauk and Fox populations, and comes to the conclusion that they increased very rapidly between 1805 and 1825. Had he carried his investigations further he would have seen that the supposed increase in reality did not take place (vide supra). TURNER (loc. cit.) also touches on the Fox population in so far as he gives various early estimates of the number of warriors, closing with 1762.

[62] Proceedings of the Mississippi Valley Historical Association, 1910–1911: 181–188.

[63] A similar error is to be found in the *Handbook of American Indians* under the article "Foxes."

[64] For example, in social organization.

[65] Bur. Amer. Ethnol. Ann. Rep. 28.

tion of linguistic assimilation does not come up at all. The argument that the Foxes were not Algonquians because "they spoke a language which could not be understood by an Ottawa interpreter," is positively ludicrous. What use would an Ottawa interpreter be among the Sauk, Kickapoo, or Delaware? He could undoubtedly understand isolated words, but not whole sentences. But what does that prove? Simply that Sauk, Kickapoo, and Delaware are too remotely related to Ottawa to be mutually intelligible. In precisely the same way an English speaking person would be useless as an interpreter among Germans unless he had studied and mastered their language. Allowing for the sake of argument that Iroquoian pottery has been found in Wisconsin in localities where the Foxes have dwelt for a long period, that does not prove the Foxes were Iroquoian in a linguistic sense, for it could easily be accounted for by acculturation. What have wars on other Algonquian tribes to do with the problem of whether or not the Foxes linguistically were Algonquian or not? The English and Germans fought against each other in the Great War. Nor have political alliances anything to do with linguistic relationship; the Japanese to-day are the allies of the English. As to the statement that they were mound builders thus resembling the Iroquois in contrast with all Algonquian tribes, which I doubt, what has a cultural phenomenon to do with a linguistic one? Or what have temperamental differences, a psychic phenomenon, to do with a linguistic problem? Nothing. The alleged original home of the Foxes in an Iroquois country is shown in the section dealing with their history to be nothing more than a misunderstanding, to put it mildly. In any case this has nothing to do with the question whether or not the Foxes were originally Iroquoian in a linguistic sense. Thus all the arguments crumble down, one by one.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

ORNITHOLOGY.—*The birds of the Tambelan Islands, South China Sea.* HARRY C. OBERHOLSER. Proc. U. S. Nat. Mus. **55**: 129–143. 1919.

The Tambelan Islands lie in the southern part of the South China Sea, about 100 miles west of Borneo. Dr. W. L. Abbott, who was the first ornithologist to explore these islands, spent two weeks there from August 3 to August 15, 1899, during which time he collected 53 birds, representing 12 species. These, together with his field notes, bring the number of avian species now known from these islands collectively up to 22. A list of these, with critical notes on specimens obtained, forms the present contribution. There are apparently few, if any, endemic forms in these islands; and their affinities so far as birds are concerned seem to be with the Anamba Islands which lie 150 miles farther north, rather than with the nearer Bornean coast. The form of *Orthorhamphus magnirostris* occurring in this region is apparently without a name and is here called *Orthorhamphus magnirostris scommophorus*. H. C. O.

ORNITHOLOGY.—*Notes on birds collected by Dr. W. L. Abbott on Pulo Taya, Berhala Strait, southeastern Sumatra.* HARRY C. OBERHOLSER. Proc. U. S. Nat. Mus. **55**: 267–274. 1919.

The island of Taya is situated at the eastern end of Berhala Strait about 30 miles north of the coast of Sumatra. Dr. W. L. Abbott visited this island and the near-by Nyamok Islets from July 26 to July 28, 1899, and obtained a small collection of 30 specimens of birds representing 8 species. Two other species were seen but not obtained. Critical notes here presented include the description of two new subspecies, *Lamprocorax panayensis richmondi* and *Cinnyris ornata microleuca*, both of which are apparently peculiar to this island. Of considerable

interest is a specimen of the rare pigeon commonly known as *Columba grisea* (Bonaparte), which Dr. Richmond renamed *Columba phasma*, but which has an earlier name in *Columba argentina* Bonaparte.

H. C. O.

ORNITHOLOGY.—*Notes on the wrens of the genus Nannus Billberg.* HARRY C. OBERHOLSER. Proc. U. S. Nat. Mus. **55**: 223–236. 1919.

The present investigation of the genus *Nannus* (olim *Anorthura*) concerns chiefly the American forms, but a few changes in Old World races are noted. Altogether there are 36 forms in the genus, and although some of these formerly stood as species, they are now considered subspecies of the European *Nannus troglodytes*. Birds from middle Europe differ from the typical race of Norway and Sweden and should be subspecifically separated as *Nannus troglodytes sylvestris* (Brehm). The bird heretofore known as *Troglodytes pallidus* Hume should now be called *Nannus troglodytes tianschanicus* (Sharpe). The race described as *Olbiorchilus fumigatus* Clark from the Amur region in eastern Siberia proves to be a good subspecies and should stand as *Nannus troglodytes amurensis* (Clark). The bird named by Buturlin *Anorthura fumigata ussuriensis* is apparently the same. The American forms of this genus are now increased to 9 by the addition of the following three new subspecies: *Nannus troglodytes kiskensis* from Kiska Island, Alaska; *Nannus troglodytes tanagensis* from Tanaga Island, Alaska; and *Nannus troglodytes petrophilus* from Unalaska Island, Alaska.

H. C. O.

ORNITHOLOGY.—*Birds of a Washington City dooryard.* HARRY C. OBERHOLSER. Amer. Midl. Nat. **6**: 1–13. 1919.

The observations here recorded were made in the built-up portion of the City of Washington from May 5, 1911, to May 1, 1918. The result again exemplifies the fact that there is ample opportunity for natural history study even in the midst of a crowded city. The total number of species herein recorded is 100, with notes on the dates of their occurrence. The largest number of these seen on any one day was 18. Among these, the most interesting for their appearance in city districts were probably *Colinus virginianus virginianus*, *Porzana carolina*, *Bartramia longicauda*, five species of the genus *Hylocichla*, and *Loxia curvirostra minor*.

H. C. O.

ORNITHOLOGY.—*Description of a new seaside sparrow from Florida.* ARTHUR H. HOWELL. Auk **36:** 86–87. January, 1919.

The discovery of a new species of bird in North America at the present time is a scientific event of some importance, although the same is not true of a subspecies. Explorations in southern Florida have brought to light what is evidently an entirely new species of the genus *Thryospiza*. It differs so remarkably from all the other forms of the genus that intergradation seems never likely to be found. It most nearly resembles *Thryospiza maritima sennetti* of the coast of Texas, from which, however, it differs conspicuously in its more sharply streaked and more extensively white lower parts. In the general character of its under parts, it is more like *Thryospiza nigrescens* of eastern Florida, but the color of its upper surface is entirely different. It is appropriately named *Thryospiza mirabilis*.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Bird records from the Sacramento Valley, California.* ALEXANDER WETMORE. Condor **21:** 73–74. 1919.

During the period between August 17 and October 17, 1918, bird observations were carried on in the Sacramento Valley, between Marysville, Maxwell, and Tehama. Notes on 12 of the most interesting species noted are presented here. The northern limit of the range of the following species in the interior of California is apparently extended by these observations: *Dendrocygna bicolor, Hydroprogne caspia imperator, Egretta thula thula,* and *Tyto alba pratincola.*

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Notes on the structure of the palate in the Icteridae.* ALEXANDER WETMORE. Auk **36:** 190–197. 1919.

The keel on the palate of the grackles of the genus *Quiscalus* is a well-known character. Investigation shows it to be a projection developed as a fold in the horny sheathing of the palate. Its use, hitherto unknown, has recently been ascertained by field observation. It is now found to be of assistance in obtaining kernels from acorns by cutting the shells, and has other similar functions. Several other genera of Icteridae have indication of a similar projection on the palate. This is most prominent in *Icterus gularis*, although apparently absent in all other species of the genus *Icterus*. In this species it is

well developed, knob-like, and almost as prominent as in *Quiscalus*. It constitutes thus an excellent generic character, and necessitates the segregation of *Icterus gularis* and its subspecies under the generic name *Andriopsar* Cassin. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Descriptions of apparently new Colombian birds.* W. E. CLYDE TODD. Proc. Biol. Soc. Wash. **32:** 113–118. June 27, 1919.

A study of the South American collections in the Carnegie Museum has resulted in the further discovery of 5 new species and 14 new subspecies, all from Colombia, brief descriptions of which appear in this paper. The species are: *Myiobius semiflavus* from El Tambor, Santander, Colombia; *Grallaria alticola* from Lagunillas, Boyaca; *Veniliornis chocoensis* from Malagita, Choco; *Odontophorus variegatus* from La Pica, Santander; and *Crypturus idoneus* from Bonda, Santa Marta. The subspecies are: *Atlapetes semirufus majusculus* from Peña Blanca, Santander, Colombia; *Phoenicothraupis rubica coccinea* from La Colorado, Boyaca; *Cistothorus aequatorialis fulvescens* from Paramo Guerrero, Santander; *Leucolepis lawrencii assimilis* from Sautata, Rio Atrato; *Leucolepis phaeocephalus propinquus* from Jaraquiel, Bolivar; *Mecocerculus leucophrys notatus* from Leonera (near Caldas); *Platytriccus albogularis neglectus* from La Colorado, Boyaca; *Pipra erythrocephala flammiceps* from El Tambor, Santander; *Pipra velutina minuscula* from Quibdo, Rio Atrato; *Hylopezus perspicillatus pallidior* from El Tambor, Santander; *Leptasthenura andicola exterior* from Lagunillas, Boyaca; *Deconychura typica minor* from El Tambor, Santander; *Celeus innotatus degener* from El Tambor, Santander; and *Nonnula frontalis pallescens* from Fundacion, Santa Marta. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*The migration of North American birds. IX. Crows.* HARRY C. OBERHOLSER. Bird Lore **21:** 100–102. 1919.

The well-known *Corvus brachyrhynchos*, as represented by five subspecies, including *Corvus brachyrhynchos caurinus*, occupies the greater part of the United States and Canada. It is resident except in the northern part of its range, for which region the dates of its spring and autumn migration are here given. The distribution of *Corvus ossifragus*, the European *Corvus frugilegus*, and the European *Corvus cornix*, are also added as of interest in this connection.

H. C. O.

ORNITHOLOGY.—*Description of a new Conurus from the Andaman Islands.* HARRY C. OBERHOLSER. Proc. Biol. Soc. Wash. **32:** 29–32. April 11, 1919.

Examples of *Conurus fasciatus* from the Andaman Islands prove to differ from the mainland birds in their larger size and paler coloration, and are here separated as a new subspecies, *Conurus fasciatus abbotti*. With this addition there are now five races of *Conurus fasciatus*.

H. C. O.

ORNITHOLOGY.—*Six new birds from Celebes and Java.* J. H. RILEY. Proc. Biol. Soc. Wash. **32:** 93–96. May 20, 1919.

Three additional species and two subspecies from Celebes and one subspecies from Java have been brought to light by further study of the bird collections made by Mr. H. C. Raven. The species are: *Megalurus celebensis* from Besoa, Celebes, the first of its genus to be found in Celebes; *Dicruropsis montana* from Besoa, Celebes; and *Pachycephala pluviosa* from Rano Rano, Celebes. The subspecies described are: *Excalfactoria chinensis palmeri* from Daroe, Java; *Anas superciliosa percna* from Koelawi, Celebes; and *Zosterops atrifrons surda* from Rano Lindoe, Celebes.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Description of a new race of the western gull.* JONATHAN DWIGHT. Proc. Biol. Soc. Wash. **32:** 11–13. February 14, 1919.

The western gull, *Larus occidentalis*, is found to be separable into a northern and a southern subspecies. The latter, which differs from the typical form of the coast of Oregon and Washington in its decidedly darker mantle and reduction of gray area on the primaries, is here named *Larus occidentalis livens*. It ranges from the coast of central California south to both coasts of Lower California.

HARRY C. OBERHOLSER.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

GEOLOGICAL SOCIETY OF WASHINGTON

338TH MEETING

The 338th meeting of the Society was held in the auditorium of the Cosmos Club on Wednesday evening, May 28, 1919, at 8 p.m.

Informal Communications

Mr. LAFORGE spoke of a fairly wide-spread misapprehension of the exact meaning of the words *talus* and *shingle* and the resultant increasing tendency to use them incorrectly. *Talus* seems to be used to some extent in the United States for the material which in reality constitutes *a* talus. The word is synonymous with *scree* which is commonly used in Great Britain. It means "a heap of coarse rock waste at the foot of a cliff or a sheet of such waste on a slope below a cliff," and its use should be confined to the heap or sheet and not extended to the constituent material, which is *rock waste*.

There seems to be a rather general idea that *shingle* means gravel composed chiefly of flattened pebbles which have been arranged by gravity, waves, or currents so as to overlap like shingles on a roof. This is entirely incorrect, as the word has no relation to the ordinary English word *shingle* (originally shindle), but is derived from the same Germanic or Norse root from which comes our common word *sing*, the *h* having been introduced through corruption, and it refers to the peculiar sound made by the material when trod upon or when rolled down the slope of the beach by a receding wave.

This brings up the question regarding the origin of the sound, and, therefore, regarding the essential or distinctive character of shingle. The dictionaries and those text-books which define the word state that it is "beach material coarser than ordinary gravel," but manifestly such a definition is inadequate, as some "singing" beaches consist of fine material and many beaches composed of coarse gravel do not "sing." Apparently the subject has not been investigated experimentally, but the number of field observations have led the speaker to the following tentative hypothesis:

The production of a sound approximating a musical note requires a certain degree of uniformity in the sound-making material and the pitch of the sound depends on the dimensions of the material, and of the resonating space, if there be any. To have such uniformity it is therefore necessary that the pebbles be of approximately the same size, hence the interstices will not be filled with finer material, as in

ordinary gravel, and resonating space of approximately uniform "mesh" will be provided. Field observation shows that it is also essential that the pebbles be of fine-grained dense rock and smoothly rounded, so that the rubbing of one upon another will tend to set up definite vibrations rather than irregular jars, and shows further that the coarser the material of a "singing" beach the lower the note produced. If this suggested explanation be correct, *shingle* should be defined as "beach material, coarser than sand, consisting of smoothly rounded pebbles of dense, fine-grained rock, of approximately the same size, and hence not having the interstices filled with finer material, which gives out a sound resembling a musical note, when trod upon or when rolled about by waves."

Mr. FRANK L. HESS said that tourmaline cobalt-bearing veins occurring in the Blackbird region, Lemhi County, Idaho, are dense black and occur in a dark, fine-grained, thin-bedded quartzite. The cobalt is in many places difficult to see, but it shows up on crushing and panning the rock. A polished section was exhibited showing a mass of microscopic tourmaline crystals with clouds of included cobalt minerals, mostly cobaltite.

Dr. H. M. AMI called attention to the fact that on the shores of the Dead Sea in Palestine there are innumerable fresh water shells washed up by the waves along with drift wood and other forms of vegetable matter. The hypersalinity of the water precludes any form of life. He surmises that these shells presumably are brought into the sea by Jordan River, and calls attention to the fact that the presence of freshwater shells in strata does not necessarily predicate that the water in which the sediments were laid down was fresh.

Regular Program

E. W. SHAW: *Present tendencies in Geology. III. Stratigraphy.* (This paper will be published later in this JOURNAL.)

M. I. GOLDMAN: *General character, mode of occurrence, and origin of glauconite.*

The characters of the mineral were briefly reviewed, and it was pointed out that there are a number of varieties in addition to the common form in rounded, compound-polarizing grains. Some of these seem to have been deposited epigenetically from solution, but the speaker did not believe that there is good evidence for the deposition of any of them from solution syngenetically. The importance of further study, especially chemically, of the well defined, micaceous green crystals sometimes found associated with the cryptocrystalline forms of glauconite, and believed to be glauconite, was emphasized.

The chemical composition and mineralogical affinities were discussed. The potassium content, which averages around 7 per cent, distinctly differentiates glauconite from the chlorites which it resembles in many of its mineralogical characters, and the predominance of

ferric over ferrous iron and the fact that glauconite seems to be an orthosilicate points in the same direction. Then too, the molecule of water which appears to be an essential part of its composition would place it rather with the vermiculites than the chlorites. Allying it with the chlorites, on the other hand, is the magnesia content which seems to be pretty persistent. The chemical composition presents a fundamental difficulty, however, since it is uncertain whether the mineral is a definite crystalline substance or a colloform mixture.

Glauconite is a characteristic phase of certain terrigenous *marine* sediments and very widely distributed around all the continents. But it is rare in the delta type of terrigenous deposit on the one hand and in pellagic deposits on the other. Concerning its mode of formation there is great uncertainty, but it seems to develop in small segregated pellets of clay (generally 1 mm. or less diam.) when there is organic matter present. The process assumed has been the reduction of the sulfates of sea water to sulfides which form iron sulfide with the iron present in the clay. This sulfide is believed to combine with silica in the clay and the iron silicate thus formed to take up potassium from the sea-water. The combination of iron sulfide with silica to form a silicate has been brought about experimentally, but the reaction was prevented by an excess of hydrogen sulfide. On the basis of the facts summarized the speaker presented the hypothesis that glauconite is one of three characteristic modes of occurrence of iron in marine deposits, being an intermediate product between high organic content and reducing conditions yielding the sulfide on the one hand, and low organic content with oxidizing conditions producing the hydrous oxides on the other.

Geologically, also, glauconite is a very widely distributed and common mineral, having been found in deposits of every period. It occurs particularly characteristically, however, just above unconformities, that is in transgressing (perhaps also in regressing) formations, and preeminently in connection with the great transgression of the lower part of the Upper Cretaceous. This stratigraphic position has not been adequately explained. The frequent association of glauconite and phosphate in both recent and ancient deposits is familiar, and Murray has pointed out a relation, at least partial, of phosphate with great extremes of surface temperatures of the ocean. Cayeux has suggested that such instabilities of temperature might be produced by extensive movements of the earth's crust and the same explanation may be applicable, in part, to the geologic occurrence of glauconite.

G. R. MANSFIELD: *General features of the glauconite marls of New Jersey.*

(This paper is to be published in *Economic Geology.*)

E. O. ULRICH: *Paleozoic glauconite zones and suggestions as to their origin.*

R. W. STONE, *Secretary.*

SCIENTIFIC NOTES AND NEWS

The Chemical Society of Washington has secured permission from Maj. Gen. William L. Sibert for its members to visit the government gas plant at Edgewood Arsenal, Edgewood, Maryland, on a Saturday about the middle of October. Others in the city who are interested will be welcome. The chemists of Philadelphia, Wilmington, and Baltimore will also visit the plant on the same day. Details of the arrangements will be announced later.

Word has been received that Messrs. ALLEN, FENNER, and ZIES, of the Geophysical Laboratory's party in Alaska, have arrived safely at Kodiak with collections of gases and emanations from the fumaroles of the Valley of Ten Thousand Smokes. This is the first news of the party since the National Geographic Society's expedition entered the Valley in June.

Mr. ROBERT ANDERSON, a petroleum geologist formerly on the U. S. Geological Survey, has returned from Stockholm, Sweden, where he represented the Shipping Board for the past 6 months, and is about to leave for London where he will have charge of geologic investigations for Pearson and Sons.

Mr. GEORGE H. ASHLEY resigned from the U. S. Geological Survey on September 1, having been appointed State Geologist of Pennsylvania.

Dr. ARTHUR F. BUDDINGTON of Brown University, recently in Washington with the Chemical Warfare Service, has joined the staff of the Geophysical Laboratory of the Carnegie Institution of Washington.

Miss ELEONORA F. BLISS, associate geologist on the U. S. Geological Survey, is on leave of absence and is visiting her father, General TASKER H. BLISS, in Paris.

Messrs. L. C. GRATON, FRANK A. HERALD, and J. H. HANCE, formerly geologists in the U. S. Geological Survey, are now engaged in expert work in the income tax section of the Internal Revenue Division of the Treasury Department.

Mr. H. E. HARING, recently in the Inspection Division of the Ordnance Department, has joined the staff of the Bureau of Standards, where he will be engaged in electrochemical research.

Prof. A. S. HITCHCOCK, systematic agrostologist in the Bureau of Plant Industry, left New York for British Guiana in September. He expects to study the grasses of that country, and will return in about four months. The work is being done in cooperation with the New York Botanical Garden and the Gray Herbarium.

Dr. ALES HRDLICKA, of the Smithsonian Institution, has been visiting Camp Dix and Camp Devens for the purpose of classifying certain anthropometric measurements being made during the demobilization of the soldiers.

Mr. PREVOST HUBBARD resigned in July from the Bureau of Public Roads, U. S. Department of Agriculture, and is now chemical engineer with the Asphalt Association, 15 Maiden Lane, New York City.

Mr. PAUL D. V. MANNING, formerly chemist with the Nitrate Division of the Ordnance Department, at the Fixed Nitrogen Research Laboratory, American University, is now electrometallurgist with the Chile Exploration Company of New York City.

Mr. LOUIS N. MARKOVITZ, who has been on leave of absence with the Chemical Warfare Service at Nela Park, Cleveland, Ohio, has returned to his work at the Insecticide Laboratory of the Bureau of Chemistry.

Dr. CHARLES L. PARSONS, Chief Chemist of the Bureau of Mines, has presented his resignation, to take effect November 1st. He has engaged offices for the American Chemical Society in the Mills Building Annex. He will also do a limited amount of private consulting and chemical engineering work.

Mr. E. W. SHAW, geologist of the U. S. Geological Survey, who has been coöperating with the Internal Revenue Office in determining the income tax on oil and gas properties, is in Europe on a two months' leave of absence doing consulting geologic work.

Dr. H. TEN KATE, the well-known anthropologist, who has been a resident of Japan for the past twelve years, visited Washington in August.

Prof. E. W. WASHBURN, recently acting chairman of the Division of Chemistry and Chemical Technology of the National Research Council, returned to the University of Illinois in September.

Mr. L. M. WHITMORE, formerly in charge of the chemical work on leather at the Bureau of Standards, resigned in August to accept a position in the Process Department of Leas and McVitty, Inc., tanners of sole leather, at Salem, Virginia.

Mr. CHARLES W. WRIGHT, a geologist formerly on the U. S. Geological Survey, who has been visiting in the United States for a month, has returned to Sardinia and Rome, where he has offices as consulting mining engineer.

Dr. RALPH W. G. WYCKOFF, of Cornell University, has joined the staff of the Geophysical Laboratory of the Carnegie Institution as assistant physicist

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